(12) UK Patent Application (19) GB (11) 2 186 769 (13) A

(43) Application published 19 Aug 1987

(21) Application No 8630807

(22) Date of filing 23 Dec 1986

(30) Priority data

(31)	(32)	(33)
60/200000	26 Dec 1985	JP
60/294346	26 Dec 1985	
60/294347	26 Dec 1985	
61/029074	28 Feb 1986	

(51) INT CL[4]
H05B 3/26

(52) Domestic classification (Edition H)
H5H 109 126 140 141 155 156 170 175 231 233 251 AF5

(56) Documents cited
GB 1053472 GB 1051777 GB 0737371 GB 0672835

(58) Field of search
H5H B5N
Selected US specifications from IPC sub-class H05B

(71) Applicants
Nippon Sheet Glass Co. Ltd.

(Incorporated in Japan)

8 4-chome Doshomachi, Higashi-ku, Osaka, Japan

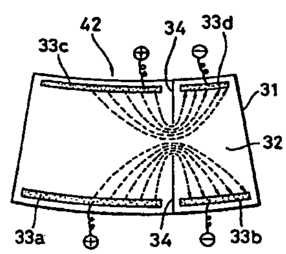
(72) Inventors
Jun Hasegawa
Jun Kawaguchi
Takashi Muromachi
Kaoru Sakurai

(74) Agent and/or Address for Service
Reddie & Grose, 16 Theobalds Road, London WC1X 8PL

(54) Conductive glass plate

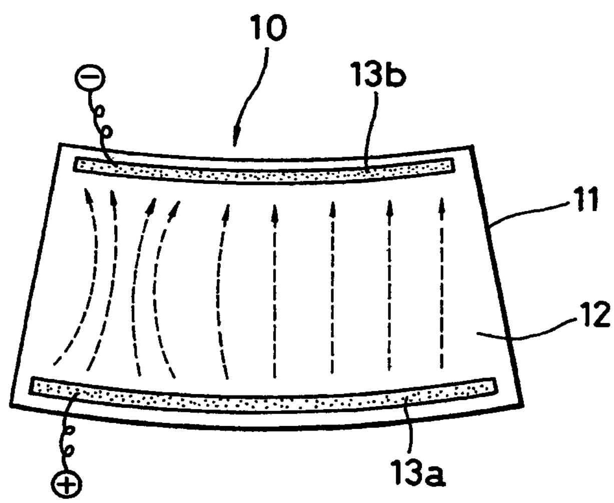
(57) A glass plate 31 has a transparent conductive film 32 on one face. A current is not supplied to the entire surface of a transparent conductive film 32 but limited by slits 34 in the film 32, so that the current is supplied along a limited current path. By attaining a predetermined current density only in a predetermined portion of the transparent conductive film, even if power consumption per unit time is small, thawing, defrosting or the like in the predetermined portion can be immediately performed. Bus bars 33a, 33b, 33c and 33d serve as terminals for voltage applied to the film 32. The pattern of current flow can be altered by altering the respective polarities of the bus bars 33. Slits 34 may be formed which completely surround areas of the film 32 which are then only heated by conduction.

FIG. 12A



GB 2 186 769 A

FIG. 1



23 DEC 83- 30807
D F A

2186769

FIG. 2

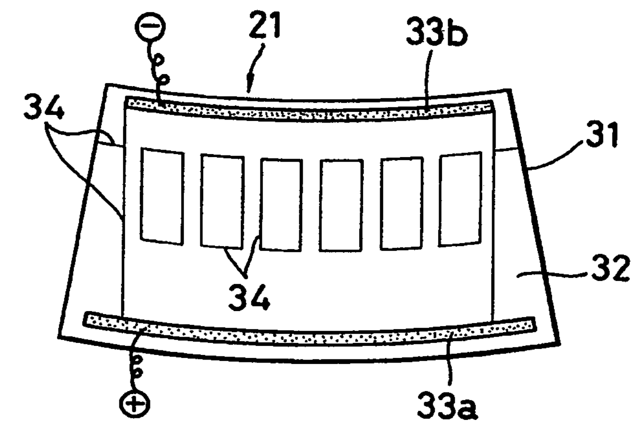


FIG. 3

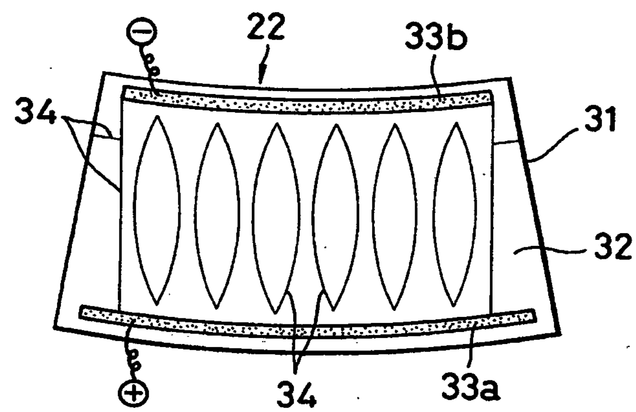
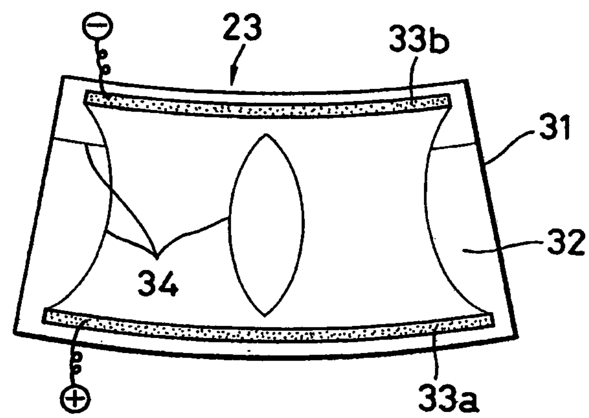


FIG. 4



DFA

FIG.5

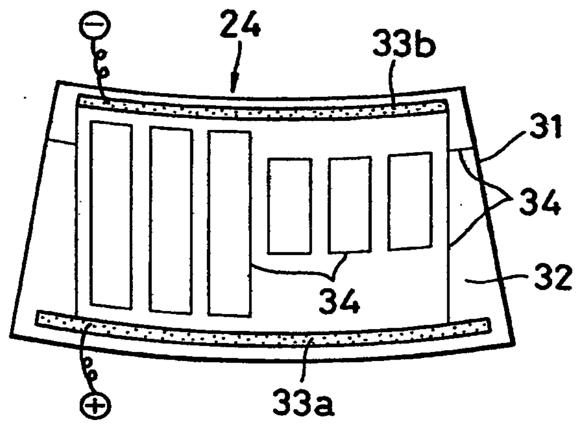


FIG.6

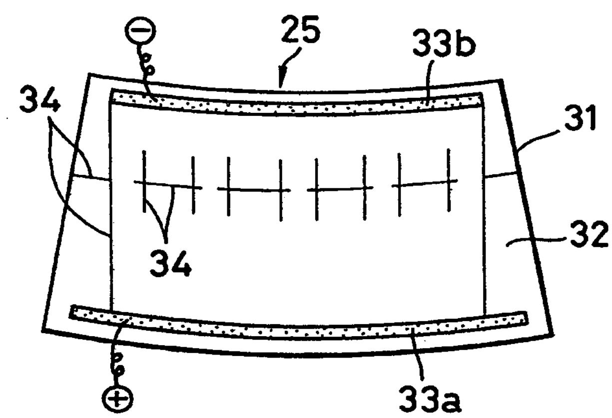


FIG.7

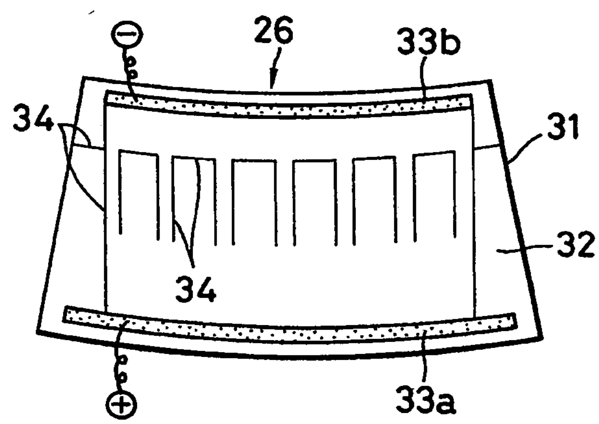


FIG. 8

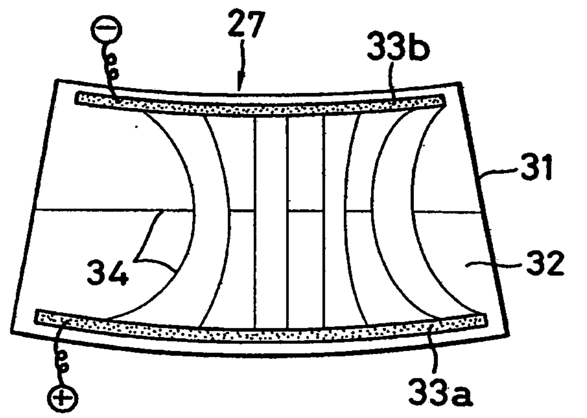


FIG. 9

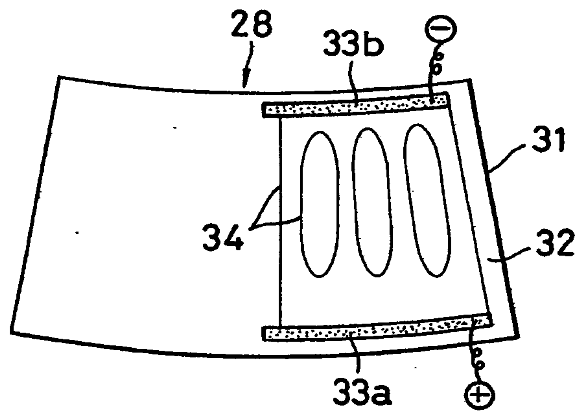
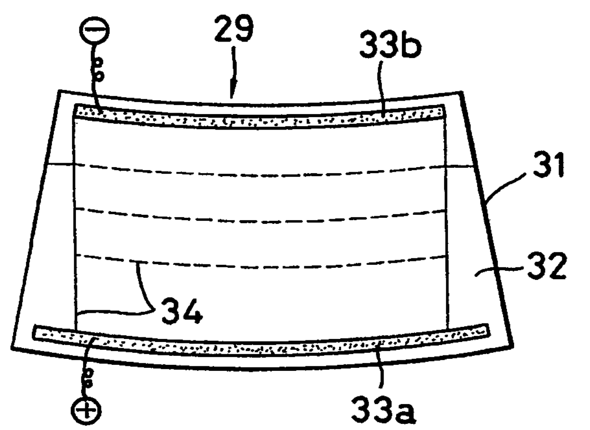


FIG. 10



23 DEC 86- 30807

FIG.11A

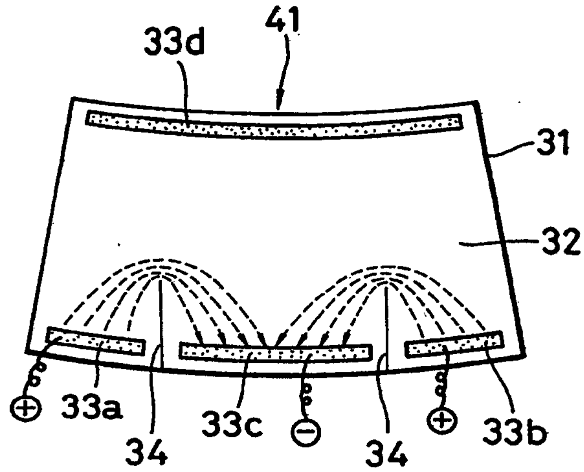
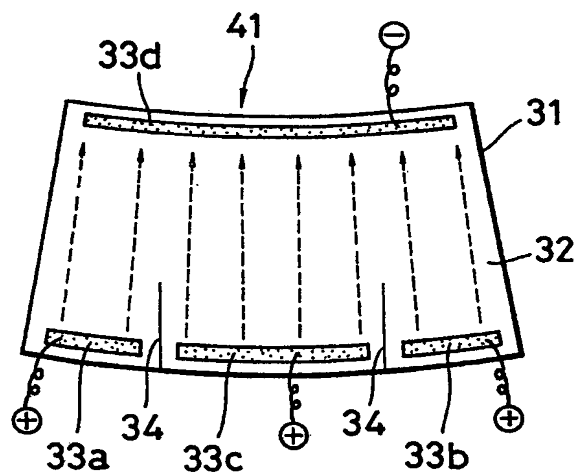


FIG.11B



23 DEC 86- 30807
DFA

2186769

FIG.12A

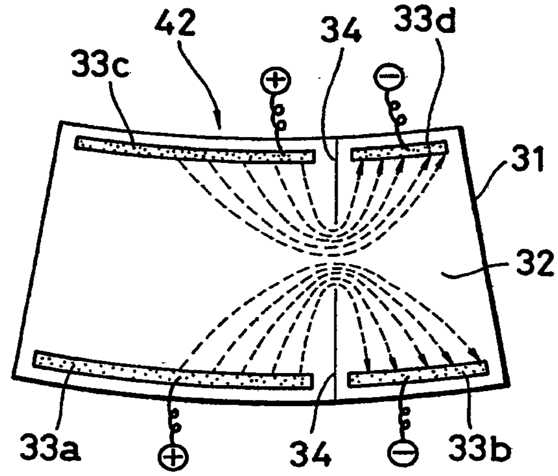
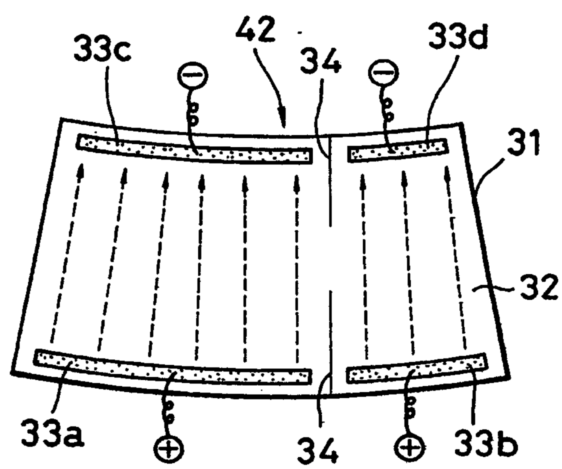


FIG.12B



2186769

FIG. 13A

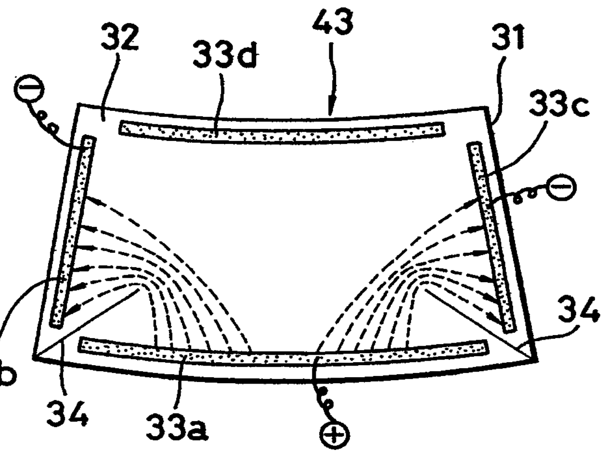


FIG. 13B

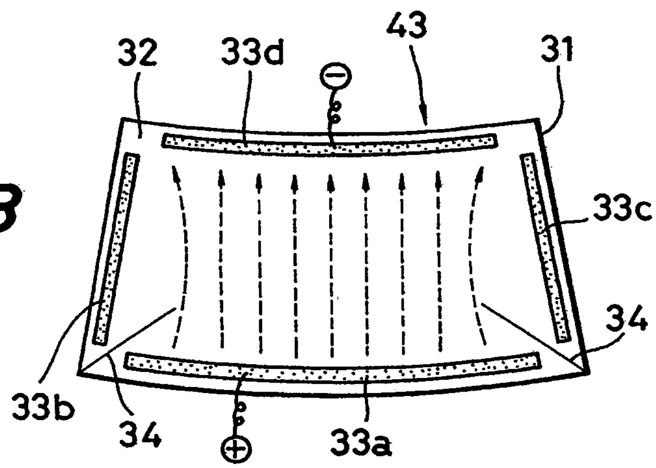


FIG. 14

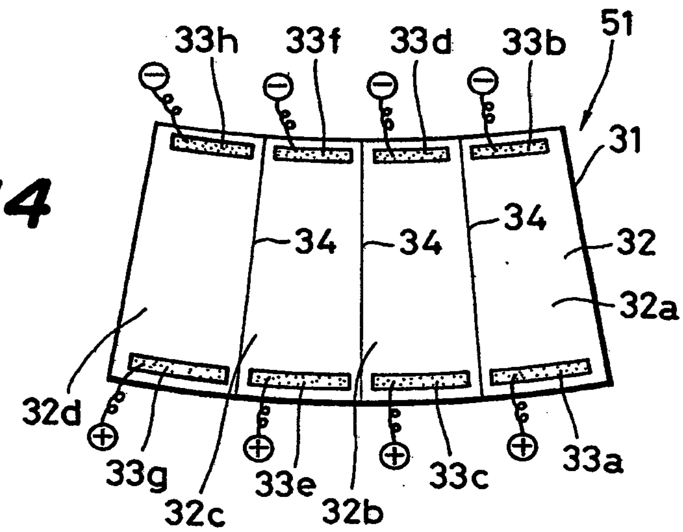

33h
33f
33d
33b
51
31
34
34
34
32
32a
32d
33g
32c
33e
32b
33c
33a

FIG. 15

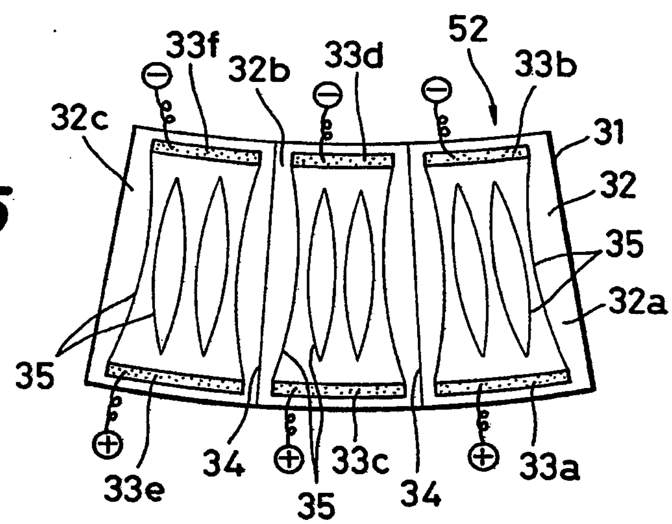

33f
32b
33d
52
33b
32c
31
32
35
32a
35
33e
34
35
33c
34
33a

FIG.16A

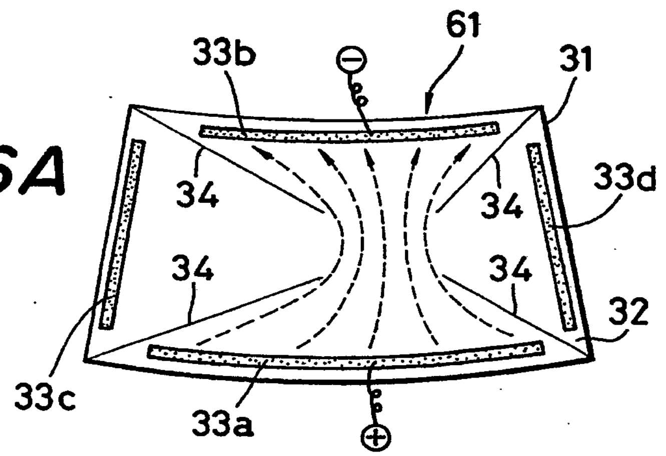


FIG.16B

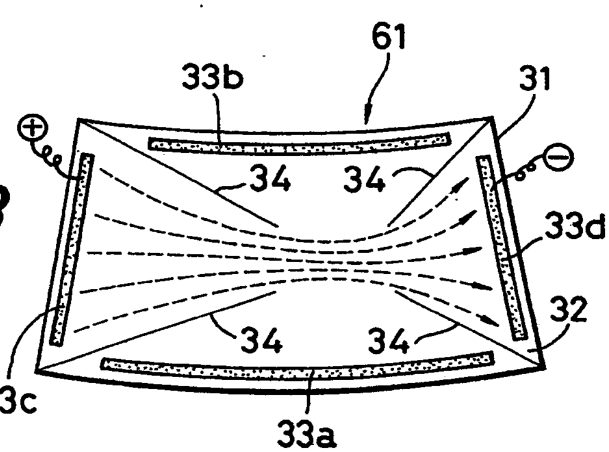


FIG.17A

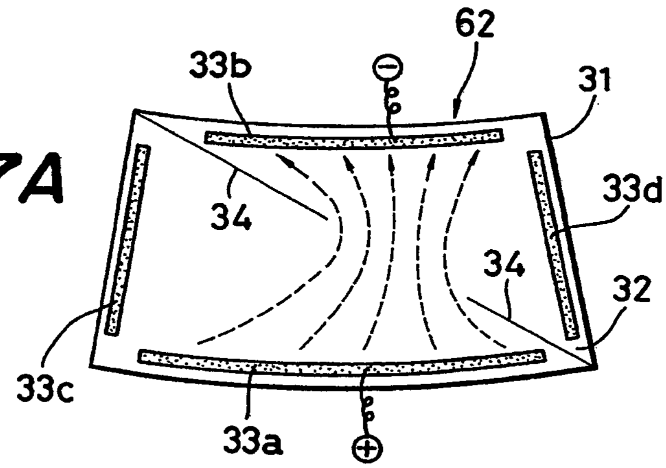
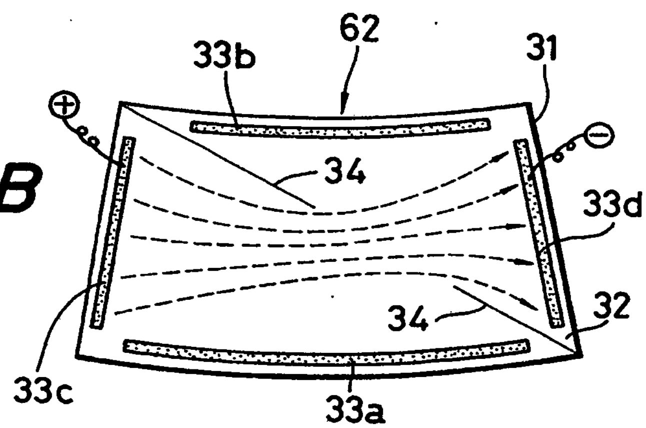


FIG.17B



23 DEC 93- 30807
D F A

2136769

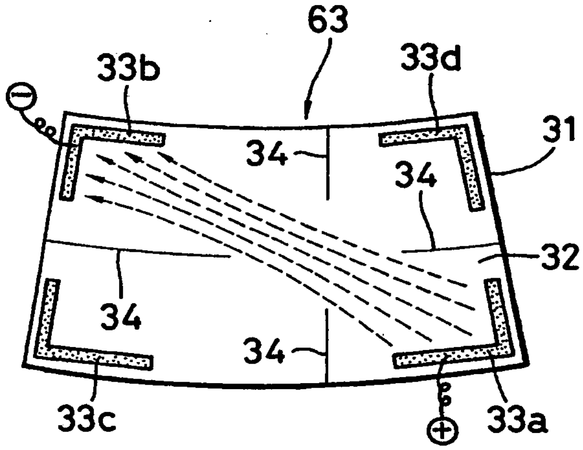


FIG.18A

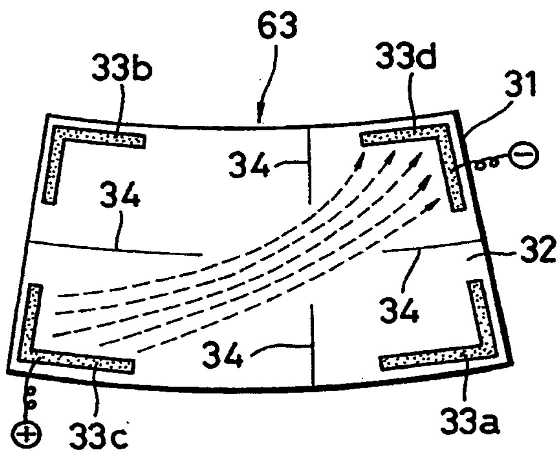


FIG.18B

SPECIFICATION

Conductive glass plate

BACKGROUND OF THE INVENTION

Field of the Invention:

The present invention relates to a conductive glass plate suitably used as window glass of an automobile or the like and electrically heated for thawing, defrosting or the like.

Description of the Prior Art:

Fig. 1 shows a typical conventional conductive glass plate. In a conductive glass plate 10, a transparent conductive film 12 containing tin oxide as a major constituent is formed on one surface of a glass plate 11, and bus bars 13a and 13b are formed along a pair of opposite edges on the same surface.

In the conductive glass plate 10, when a voltage is applied across the bus bars 13a and 13b to perform thawing, defrosting or the like, a current is supplied to substantially the entire surface of the transparent conductive film 12.

The electric resistance of the transparent conductive film 12 between the bus bars 13a and 13b is as large as about 2.5 Ω. For this reason, in order to supply a current of, e.g., 20 A to the entire surface of the transparent conductive film 12, a relatively high voltage of 50 V is required. Therefore, high power consumption is required to perform thawing, defrosting or the like. And, if power consumption per unit time is reduced, high-speed thawing, defrosting or the like cannot be achieved.

If the transparent conductive film 12 has a nonuniform thickness, its electrical resistance has a nonuniform distribution. When a current is supplied to substantially the entire surface of the transparent conductive film 12, the resultant current density becomes nonuniform, as indicated by broken lines in Fig. 1. As a result, a portion having a high current density is abnormally heated to degrade the transparent conductive film 12.

SUMMARY OF THE INVENTION

A conductive glass plate according to the present invention is designed so that a current is not supplied to the entire surface of a transparent conductive film, and flow paths of the current are limited by slits.

A predetermined current density can be obtained for predetermined portions of the transparent conductive film, and thawing, defrosting or the like can be quickly performed for the predetermined portions even if power consumption per unit time is low.

Alternatively, a comb-like current path is used to prevent variations in current density and hence abnormal heating. As a result, degradation or the like of the transparent conductive film can be prevented.

Furthermore, a proper slit pattern is selected to control the current densities of different areas of the glass plate, and the areas have a priority order for thawing, defrosting or the like.

Since a slit width can be 0.1 mm or less, the outer appearance of the transparent conductive film is not impaired, and the driver's field of view can be guaranteed. In addition, this arrangement also serves to reflect solar heat.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front view of a conventional example; and Figs. 2 to 18B are front views showing first to seventeenth embodiments of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A three-layered transparent conductive film 32 is formed by sputtering or the like on one surface of a glass plate 31 in each of conductive glass plates 21 to 29 according to first to ninth embodiments of the present invention. The three-layered structure comprises a MO_x-Ag-MO_x structure (wherein $MO_x = SnO_2$, ZnO, In_2O_3, ITO, TiO_2, or the like). Bus bars 33a and 33b are formed along a pair of opposite edges of the glass plate 31 on the same surface in each of the plates 21 to 29, except that the bus bars 33a and 33b in the eighth embodiment of Fig. 9 extend up to half the entire sides of the glass plate 31.

Slits 34 are formed in each transparent conductive film 32 by mechanical cutting (a width is 20 to 40 μm) by a blade, laser cutting (a width is several micrometers) or the like.

The slits 34 have different patterns, as shown in Figs. 2 to 10. In any case, the slits 34 include length components of longitudinal directions in direction wherein the bus bars 33a and 33b extend.

In each of the conductive glass plates 21 to 28, when a voltage is applied between the bus bars 33a and 33b, a current is not supplied across the slits 34. Since the slits 34 are formed such that the slits 34 include the length components of longitudinal directions in direction wherein the bus bars 33a and 33b extend, nonconductive portions are formed by the slits 34, so that a current is supplied in conductive portions between the nonconductive portions.

A ratio of a conductive portion width to a nonconductive portion width falls within the range between 1 : 2 and 1 : 5 in the first to ninth embodiments. Power required to obtain the same current density of the conductive portion as in the conventional case is reduced to 1/2 to 1/5. Thawing, defrosting or the like in the nonconductive portions are performed by heat conduction from the conductive portions.

If the absolute width of each conductive portion is excessively reduced even if the ratio of the conductive portion width to the nonconductive portion width falls within the range between 1 : 2 and 1 : 5, that is, if the number of slits 34 is excessively large, the field of view may be interfered by these many slits 34. For this reason, the conductive portion width is set to be about 10 to 50 mm in the first to ninth embodiments.

When the width of the slit 34 exceeds 100 μm, the slit 34 becomes visually conspicuous. When the width falls within the range between 50 μm and 100 μm, the slit 34 is not conspicuous but can be identified by a naked eye. However, when the width falls within the range between 20 μm and 50 μm, the slit 34 can rarely be identified by the naked eye. When the width falls within the range between 1 μm and 20μm, the slit 34 cannot be identified by the naked eye at all. However, if the width is 1 μm or less, the slit 34 cannot be satisfactorily formed. In other words, the slit forming process becomes unstable, and complete slits cannot be formed.

The width of the slit 34 must be 100 μm or less and preferably falls within the range between several

micrometers and 50 μm. Thus the widths in the first to ninth embodiments are defined as described above.

The transparent conductive film 32 need not be a multi-layered film, but may be a single layer of SnO_2, In_2O_3 or the like.

Two slits 34 are formed by mechanical cutting (a width is 20 μm to 40 μm) using a blade, laser cutting (a width is several micrometers) or the like in a transparent conductive film 32 on a conductive glass plate 41 according to a tenth embodiment in Fig. 11A and 11B. The two slits 34 vertically extend from one side to about the center of the transparent conductive film 32.

On the surface of the glass plate 41 with the transparent conductive film 32, bus bars 33a, 33b, and 33c extend along one side with slits so as to interpose the slits 34 therebetween. A bus bar 33d extends along substantially the entire side opposite to one side with slits.

In the conductive glass plate 41, a voltage is applied to the bus bars 33a to 33c such that the bus bars 33a and 33b serve as anodes and the bus bar 33c serves as a cathode, and that the bus bar 33d is kept deenergised.

In this state, a current tends to be supplied from the bars 33a and 33b to the bus bar 33c. However, the current is not supplied to cross the slits 34. Therefore, the current detours the slits 34, as indicated by broken lines in Fig. 11A.

For this reason, the current density near the distal ends of the slits 34 is higher than that at the other portions. Even if a voltage appled to the bus bars 33a to 33c is not so high, thawing, defrosting or the like are immediately performed near the distal ends of the slits 34.

When thawing, defrosting or the like near the distal ends of the slits 34 are completed, the polarity of the voltage applied to the bus bar 33c is inverted to the positive polarity, and at the same time a negative voltage is applied to the bus bar 33d, as shown in Fig. 11B.

A current is uniformly supplied to substantially the entire surface of the transparent conductive film 32, as indicated by dotted lines in Fig. 11B. Thawing, defrosting or the like are slowly performed for the entire surface of the transparent conductive film 32.

A conductive glass plate 42 according to an eleventh embodiment of Figs. 12A and 12B is substantially the same as that of the tenth embodiment, except that a pair of slits 34 extend from opposite sides of the transparent conductive film 32 so as to come close to each other and bus bars 33a and 33b and bus bars 33c and 33d are formed at opposite sides so as to interpose the corresponding slits 34.

As shown in Fig. 12A, in the conductive glass plate 42, a voltage is applied to the bus bars 33a to 33d such that the bus bars 33a and 33c serve as anodes and the bus bars 33b and 33d serve as cathodes. In this case, thawing, defrosting or the like are performed at a portion between the distal ends of the slits 34, i.e., a portion having a high current density.

Thereafter, as shown in Fig. 12B, the polarity of the bus bars 33b is changed to the positive polarity, and the polarity of the bus bar 33c is changed to the negative polarity to peform thawing, defrosting or the like substantially on the entire surface of the transparent conductive film 32.

A conductive glass plate 43 in a twelth embodiment of Figs. 13A and 13B is substantially the same as the conductive glass plate 41 of the tenth embodiment, except that slits 34 extend from two adjacent corners toward the center of a transparent conductive film 32 and that bus bars 33a to 33d respectively extend along four sides of the transparent conductive film 32.

In this conductive glass plate 43, a voltage is selectively applied to the bus bars 33a to 33d such that the bus bar 33a serves as an anode and the bus bars 33b and 33c serve as cathodes to perform thawing, frosting or the like at a portion near the distal ends of the slits 34, i.e., a portion having a high current density, as shown in Fig. 13A.

Thereafter, as shown in Fig. 13B, the bus bars 33b and 33c are deenergised, and at the same time a negative voltage is applied to the bus bar 33d to perform thawing, defrosting or the like for substantially the entire surface of the transparent conductive film 32.

Three slits 34 equidistantly extend along a direction perpendicular to a pair of opposite sides of a transparent conductive film 32 in a conductive glass plate 51 according to a thirteenth embodiment of Fig. 14. These slits 34 are formed by a mechanical cutting (a width is 20 to 40 μm) using a blade, laser cutting (a width is several micrometers), or the like.

The transparent conductive film 32 is divided into four equal areas 32a to 32d by the slits 34. Bus bars 33a and 33b, 33c and 33d, 33e and 33f, and 33g and 33h extend along pairs of opposite sides of the areas 32a to 33d, respectively.

In the conductive glass plate 51 having the construction described above, a voltage is applied at first to only the bus bars 33a and 33b, and the bus bars 33c to 33h are kept deenergised. A current is supplied between the bus bars 33a and 33b but is not supplied to cross the slit 34. As a result, the current is supplied to only the area 32a.

Even if a voltage applied to the bus bars 33a and 33b does not have a large magnitude, a predetermined current density can be obtained within the area 32a. In other words, even if power consumption per unit time is not so large, thawing, defrosting or the like are performed for at least the area 32a. When thawing, defrosting or the like within the area 32a are completed, a voltage is sequentially applied between the bus bars 33c and 33d, 33e and 33f, and 33g to 33h to energise the areas 32b, 32c, and 32d so as to perform independent thawing, defrosting or the like in these areas.

However, thawing, defrosting or the like need not be sequentially performed in the order of the areas 32a to 32d. If the amount of ice or frost attached to the conductive glass plate 51 is small, the areas 32a to 32d may be simultaneously energised.

A conductive glass plate 52 according to a fourteenth embodiment of Fig. 15 is substantially the same as the conductive glass plate 51 of the thirteenth embodiment, except that in addition to two slits 34, slits 35 including length components of longitudinal directions in direction wherein bus bars 33a to 33f extend are respectively formed within the areas 32a to 32c.

Since the slits 35 are formed so as to include length components of longitudinal directions in direction wherein the bus bars 33a to 33f extend in the conductive glass plate 52, these slits 35 define nonconductive portions, and a current is supplied between conductive portions defined by the nonconductive portions.

Power consumption for obtaining the same current density in the conductive portion as in the thirteenth embodiment can be reduced in the fourteenth embodiment. It should be noted that thawing, defrosting or the like in the nonconductive portions are performed by heat conduction from the conductive portions.

Four slits 34 extend from four corners to the vicinity of the center of a transparent conductive film 32 in a conductive glass plate 61 according to a fifteenth embodiment of Figs. 16A to 16B. These slits 34 are formed by mechanical cutting (a width is about 20 to 40 μm) using a blade, laser cutting (a width is several micrometers), or the like.

Bus bars 33a to 33d are respectively formed along four sides on the same surface of the glass plate 61 with the transparent conductive film 32, except for the corners of the plate 61.

In the conductive glass plate 61, a voltage is selectively applied to the bus bars 33a to 33d such that at first the bus bar 33a serves as an anode and the bus bar 33b serves as a cathode, and that the bus bars 33c and 33d are kept deenergised, as shown in Fig. 16A.

In this state, a current tends to be supplied from the bus bar 33a to the bus bar 33b, but does not cross the slits 34. As indicated by broken lines in Fig. 16A, the current is supplied so as to detour the slits 34.

Therefore, a portion defined by the distal ends of the slits 34, i.e., the central portion of the transparent conductive film 32 has a highest current density. Even if the voltage applied to the bus bars 33a and 33b does not have a large magnitude, thawing, defrosting or the like are immediately performed at the central portion of the transparent conductive film 32.

When thawing, defrosting or the like at the central portion of the transparent conductive film 32 are completed to a given extent, a voltage is then selectively applied to the bus bars 33a to 33d such that the bus bar 33c serves as an anode and the bus bar 33d serves as a cathode, and that the bus bars 33a and 34b are deenergised, as shown in Fig. 16B.

As indicated by broken lines in Fig. 16B, the central portion of the transparent conductive film 32 has the highest current density.

When thawing, defrosting or the like at the central portion of the transparent conductive film 32 are completed, thawing, defrosting or the like at other portions have not yet been completed although have progressed to a given extent that the driver's field of view is guaranteed. When the application of the voltage to the bus bars 33a and 33b and bars 33c and 33d continues, thawing, defrosting or the like throughout the transparent conductive film 32 are completed.

A conductive glass plate 62 according to a sixteenth embodiment of Figs., 17A and 17B is substantially the same as the conductive glass plate 61 of the fifteenth embodiment, except that only two diagonal slits 34 are formed in a transparent conductive film 32.

In the conductive glass plate 62, a voltage is applied at first to the bus bars 33a and 33b such that the bus bar 33a serves as an anode and the bus bar 33b serves as a cathode, as shown in Fig. 17A. Thereafter, a voltage is applied to the bus bars 33c and 33d such that the bus bar 33c serves as an anode and the bus bar 33d serves as a cathode, as shown in Fig. 17B.

Thawing, defrosting or the like at the central portion of the transparent conductive film 32 in the conductive glass plate 62 are immediately performed. These operations in other portions are also performed to a given extent within a short period of time.

A conductive glass plate 63 according to a seventeenth embodiment of Figs. 18A and 18B is substantially the same as the conductive glass plate 61 of the sixteenth embodiment, except that slits 34 extend from four sides to the vicinity of the center and L-shaped bus bars 33a to 33d are formed at four corners of a transparent conductive film 32. In this case, each slit 34 in opposite pairs comes close to each other.

In the conductive glass plate 63, a voltage is applied at first to bus bars 33a and 33b such that the bus bar 33a serves as an anode and the bus bar 33b serves as a cathode, as shown in Fig. 18A. Thereafter, a voltage is applied to the bus bars 33c and 33d such that the bus bar 33c serves as an anode and the bus bar 33d serves as a cathode, as shown in Fig. 18B.

Thawing, defrosting or the like at the central portion of the transparent conductive film 32 in the conductive glass plate 63 are immediately performed, and the identical operations in other portions are performed to a given extent within a short period of time.

Although the transparent conductive film 32 and the bus bars 33a to 33h are formed on one surface of the glass plate 31 in any embodiment described above, the transparent conductive film 32 and the bus bars 33a to 33h may be formed in a laminated glass.

CLAIMS

1. A conductive glass plate comprising:

a transparent conductive film attached to a glass plate;

at least two bus bars attached to said glass plate to energise said transparent conductive film; and

slits formed in said transparent conductive film to limit a current path between said bus bars.

2. A plate according to claim 1, wherein said bus bars oppose each other in a direction perpendicular to an extension direction of said bus bars, and said slits include length components of longitudinal directions in direction wherein said bus bars extend.

3. A plate according to claim 1, wherein said slits extend from edges of said transparent conductive film to a predetermined portion in said transparent conductive film, and said two bus bars are independently located at two sides of each of said slits.

4. A plate according to claim 1, wherein said slits extend from edges of said transparent conductive film to a predetermined portion in said transparent conductive film, said two bus bars are independently located at two sides of each of said slits, and a third bus bar is arranged to oppose at least one of said two bus bars.

5. A plate according to claim 1, wherein said slits divide said transparent conductive film into a plurality

of areas, and at least two bus bars are arranged in each of said plurality of areas.

6. A plate according to claim 1, wherein said slits extend from opposite edges of said transparent conductive film to come close to each other, and a plurality of bus bars are respectively arranged along all sides of said glass plate.

7. A plate according to any one of claims 1 to 6, wherein each of said slits has a width of not more than 100 μm.

Printed in the United Kingdom for Her Majesty's Stationery Office by the Tweeddale Press Group, 8991685, 8/87 18996. Published at the Patent Office, 25 Southampton Buildings, London WC2A 1AY, from which copies may be obtained.